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MEASUREMENT OF INSTABILITY IN FISHERIES

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Concept

The measure that is used to estimate instability in a variable over time should satisfy two minimum properties. It should not include deviations in the data series that arise due to secular trend or growth. Two, it should be comparable across data sets having different means.

One way to exclude variations in a data series due to the trend, is, to fit a suitable trend (for example $Y_t = a + bT + e_t$; where Y is dependent variable like prices or production, T refers to time, a is intercept and b is slope) and de-trend the series. This is done by computing residuals [e_t = Y- (a + bT)], i. e. deviations between actual and estimated trend values, and estimating instability based on e_t. As mean of e_t is always zero, their standard deviation is used to measure instability. The main problem with this is comparability across data sets having different mean values. This necessitates use of Coefficient of Variation (CV), instead of standard deviation (SD), to measure dispersion. As "mean" of detrended residuals is zero, it is not possible to compute CV of residuals (e_t), however, researchers have developed some methods to compute CV that is based on residuals. Mehra (1981) used standard deviation in residuals divided by mean of the variable (Area, production or yield) to compute and compare instability in agricultural production before and after introduction of new technology. The author termed the estimate as coefficient of variation even though it does not follow standardized definition of CV. Hazell (1982) developed a new method to make use of residuals to estimate instability, which was slightly different than the measure developed by Mehra (1981). Hazell detrended the data and constructed a variable (Z_t) which was computed by adding mean of the dependent variable to residuals e_t as under: $Z_t = e_t + Y$. Coefficient of variation of Z_t was used as a measure of instability. The measures of instability proposed by Mehra (1981) and Hazell (1982) are based on detrended data, they are unit free and imparts comparability. However, these methodologies have been criticized for measuring instability around an arbitrarily assumed trend line which greatly influences inference regarding changes in instability (Ray, 1983a).

Ray (1983b) developed a very simple measure of instability given by standard deviation in annual growth rates. The method satisfies the properties like instability based on detrended data and comparability. Moreover, the methodology does not involve actual estimation of trend, computation of residuals and detrending, but all these are taken care in the standard deviation of annual growth rate. This method also does not suffer from the limitations like arbitrary choice of assumed trend line initially proposed and used by Hazell (1982) and subsequently applied by Larson *et al.,* (2004) and Sharma *et al.,* (2006).

Effect of Choice of Period on Instability

It is pertinent to point out that the selection or length of period can result in significant changes in instability particularly if two sub periods with different dimensions of instability or pooled into one. This is demonstrated in Table 1 for food grains at all India level. The table presents estimates of instability (C.V.) derived from detrended yield, detrended production and production taken as product of the detrended area and detrended yield, as used by Hazell (1982), Larson *et al.,* (2004) and Sharma *et al.,* (2006).

Instability in food grain yield measured by the CV in detrended yield was 4.50 in pre green revolution period (same as reported by Larson *et al.,* 2004) and, it increased to 5.06 in the post green revolution period that covers the period 1968 to 1988. Variability in yield dropped to 3.72 after 1989 indicating a decline of 26.5

per cent in the second phase of green revolution as compared to the first phase and a decline of 17.3 per cent compared to pre green revolution period. If both these sub periods are pooled then instability in yield turns out to be 5.50 which is 22.2 per cent higher than the pre green revolution period. These differences lead to totally different types of inference about effect of improved technology on instability in food grain productivity. According to pooled data for post green revolution (1968 to 2007) spread of new technology was accompanied by an increase in yield variability, whereas, dividing post green revolution period into two sub period shows increase in variability in the initial years of adoption of new technology and a sharp decline with spread of new technology after 1988. Another conclusion that follows from these results is that there could be a complete change in the effect of factors like new technology between short and long term.

Table 1: Coefficient of variation (%) in detrended yield and production of food grains in India during different periods

Period	Production	Production = Detrended A * detrended Y	Yield
1951-65	6.11	5.73	4.50
1968-88	6.32	6.43	5.06
1989-07	4.94	5.02	3.72
1968-02	5.47	5.51	5.30
1968-07	6.30	6.52	5.50

Source: Agricultural Statistics at a Glance 2008, Ministry of Agriculture, GOI, New Delhi

Almost similar pattern is observed in the case of production of food grains whether we use data on detrended production or we use detrended production data obtained by multiplying detrended area and detrended yield. Instability in food grain production during 1951 to 1965 was 6.11 (same as reported by Larson *et al.,* 2004), and it increased with the introduction of new technology in India. Food grain production show much higher fluctuations in post green revolution period compared to pre green revolution period when no distinction is made between different sub periods. When a distinction is drawn by splitting post green revolution period into sub periods the conclusion on effect of new technology on production variability changes altogether (Table 1). This formed the basis for us to examine instability in agricultural production by dividing the period after introduction of new technology into two phases.

This paper preferred to use the method proposed by Ray (1983b) and applied by Ray (1983a), Mahendradev (1987) and Rao *et al.,* (1988) to estimate instability in agricultural production. This method is given by:

Instability index = Standard deviation of natural logarithm (Y_{t+1}/ Y_t)

where, Y_{t+1} is for the current year/month and, Y_t is the production / price in the previous year/month. This index is unit free and very robust, and it measures deviations from the underlying trend (log linear in this case). When there are no deviations from trend, the ratio of Y_{t+1}/ Y_t is constant and thus standard deviation is zero. As the series fluctuates more, the ratio of Y_{t+1} and Y_t also fluctuates more, and standard deviation increases (Chand and Raju, 2008; 2009, Chand *et al.,* 2011 and Raju *et al.,* 2014).

Example:

Tuna Price Instability in Andhra Pradesh – A case study

Instability in month wise average prices of tuna experienced at Lawson Bay landing centre, Visakhapatnam district of Andhra Pradesh during 36 months before and after November, 2014 has been presented in Table 2. Instability index for prices has shown decrease after November 2014. It decreased from 13.08 per cent to 4.39 per cent in tuna (Table 2).

Table 2: Month wise average Prices of tuna and its instability at Lawson Bay landing centre, Visakhapatnam district of Andhra Pradesh

S.No.	Year	Month	Tuna Price(Rs/kg)	ln of growth
1.	2013	June	123	-
2.	2013	July	105	-0.15822
3.	2013	August	96	-0.08961
4.	2013	September	103	0.070381
5.	2013	October	99	-0.03961
6.	2013	November	115	0.149812
7.	2013	December	120	0.04256
8.	2014	January	125	0.040822
9.	2014	February	140	0.113329
10.	2014	March	138	-0.01439
11.	2014	April	138	0
12.	2014	May	143	0.035591
13.	2014	June	103	-0.32812
14.	2014	July	134	0.263111
15.	2014	August	136	0.014815
16.	2014	September	124	-0.09237
17.	2014	October	135	0.084993
18.	2014	November	130	-0.03774
19.	2014	December	130	0
20.	2015	January	133	0.022815
21.	2015	February	132	-0.00755
22.	2015	March	128	-0.03077
23.	2015	April	140	0.089612
24.	2015	May	143	0.021202
25.	2015	June	135	-0.05757
26.	2015	July	137	0.014706
27.	2015	August	135	-0.01471
28.	2015	September	140	0.036368
29.	2015	October	131	-0.06645
30.	2015	November	138	0.052056
31.	2015	December	137	-0.00727
32.	2016	January	138	0.007273
33.	2016	February	137	-0.00727
34.	2016	March	138	0.007273
35.	2016	April	148	0.069959
36.	2016	May	137	-0.07723
Instability (Period I)	SD of Jun 13 to Nov 14			0.130847
Instability (Period II)	SD of Nov 14 to May 16			0.043895

Steps involved in the Instability calculation:

Step 1: Calculate natural logarithm of growth between current and previous month

Step 2: Calculate the Standard Deviation (SD) of the selected period eg : June 2103 to November 2014

Suggested Readings

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